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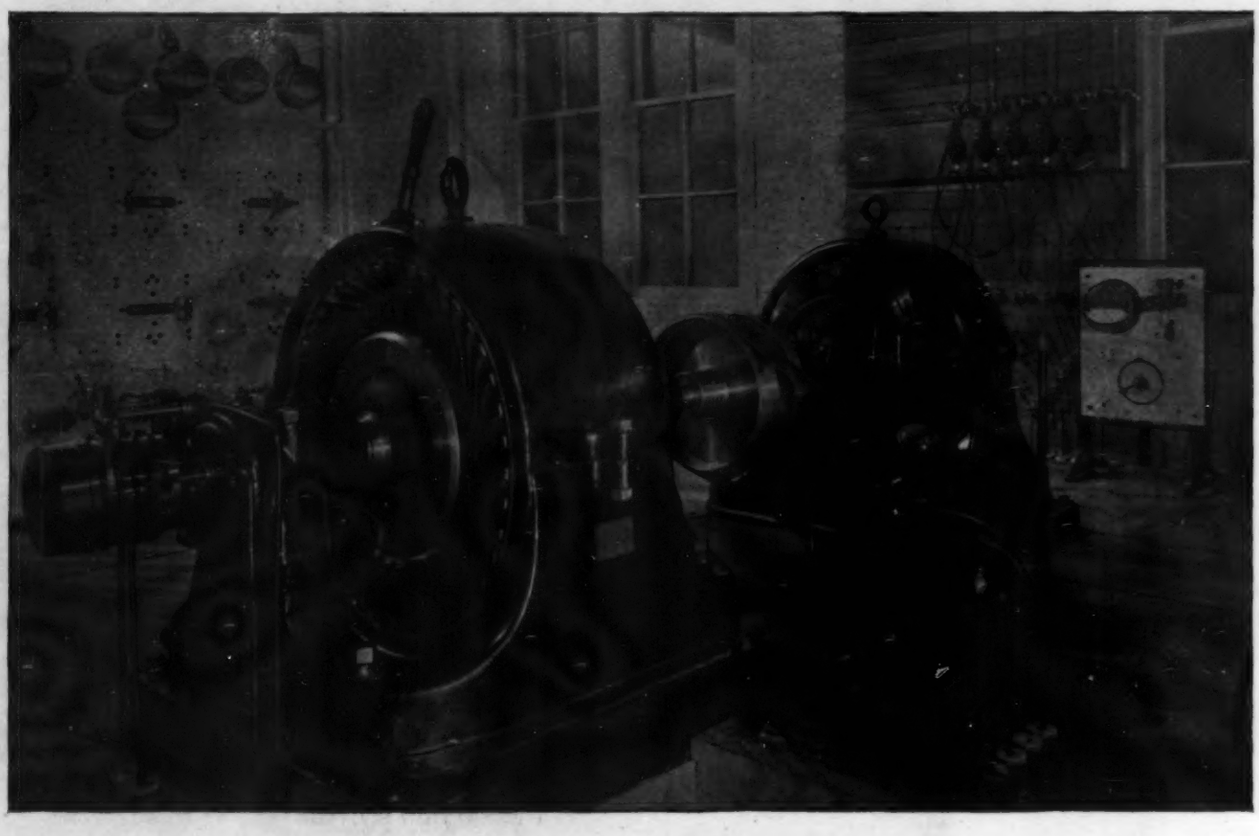
The Newcastle-Sacramento Transmission

ON the Sierra Nevada Divide southeast of Sacramento, Cal., the South Yuba Water Company owns and operates an enormous irrigating system, with nineteen storage basins, over 400 miles of canals, thirteen distributing reservoirs, and a network of canals, flumes, tunnels, pipe lines and lakes, covering two counties. At various points on the canal system are "drops," or sudden falls. The most important "drop" is one of 464 feet, of which 452 feet is utilized for the driving of the power plant of the Central California Electric Company, a corporation closely allied to the South Yuba Water Company. This constitutes the Newcastle-Sacramento transmission plant, which in many respects is one of the most interesting installations in the West, and while it has been described in a recent number of the "Electrical World" (Vol. XXX, No. 25), there are a number of interesting features concerning the plant that have not been published heretofore.

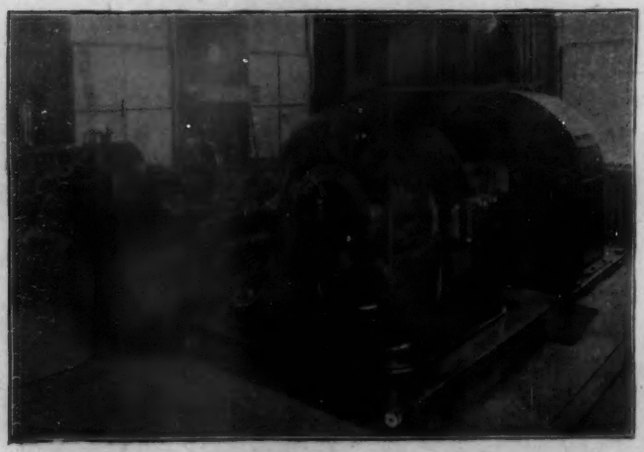
The water is carried from a reservoir to the power house, a distance of 6400 feet, in a 24-inch pipe of riveted sheet steel. The pipe is buried about two feet underground and its thickness increases as it approaches the power house from No. 12 to No. 6, B. W. G. At the power house the pipe forks, in a heavy cast-iron Y, into two 15-inch pipes of No. 6 steel, running to the Ys on the Pelton water wheels.



DIRECT CONNECTED SYNCHRONOUS MOTOR AND WESTINGHOUSE ARC MACHINE AT SACRAMENTO

These wheels are a special design of the double pattern, two 48-inch wheels being direct coupled to each of the two 400 k. w. generators. The wheel buckets are of the Dodd pattern, with nozzles arranged to be deflected by means of hand levers located near the switchboard. No automatic water wheel governors are used, the regulation being effected manually by the switch-

board attendant. This does not require very close attention, as the plant runs under a load so evenly laid on or taken off that every change can be anticipated, and even a waste of water avoided. The tail races are of substantial construction, and have heavy granite slabs at the bottoms. The power house foundations are about six feet deep, and of concrete and granite, the building



ONE OF THE GENERATOR AND WATER WHEEL UNITS

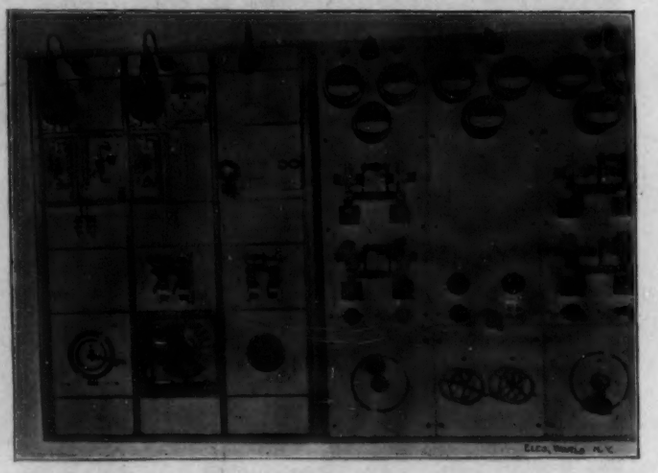
itself being 80 feet by 30 feet, and its sides and roof are constructed of corrugated iron on a wooden framework.

The entire equipment is of Westinghouse manufacture and the two 400 k. w. generators used are of the inwardly projecting field and revolving armature type, running at a speed of 400 r. p. m. They generate two-phase alternating current of 7200 alternations per minute, at 500 volts. The armature is not wound with wire, but with copper straps of the form and dimensions best suited to the armature slots. Each coil consists of a single turn of this copper strap, which is thoroughly insulated before it is placed in the armature grooves. After the coil is in position, strips of fibre are placed in each slot just over the bar and held in place by fitting into small grooves in the sides of the slots. Ventilation of the armature is effected by a number of radial openings between the laminations, from the open spider to the surface. The machines are excited by two 15 k. w. 125-volt exciters, driven by separate wheels, each exciter having ample capacity for exciting both of the generators.

No difficulty is experienced in running these exciters separately from the main pipe line, by a frequently suggested liability of the small nozzles being stopped up by sticks and nuts which may come down in the main pipe. To avoid this difficulty the exciter pipe is tapped into the top of the main pipe above the main gates and Y. The flow of water in this small pipe is so slow in comparison with the flow in the large pipe, that any solid matter is immediately carried through with the main stream. The exciters can be exchanged and one put in place of the other without the slightest variation in the lights, and they can be exchanged, in case of accident to either, in less than twenty seconds. This is a marked advantage over the system of belting the exciters from the main wheel, as the starting of a main wheel and generator must necessarily occupy more time than the simple exchange of exciters.

The wires from the machines lead directly to the main switchboard, which consists of three panels, one for each generator and one for the exciters. Each panel is provided with two double-pole carbon-break switches, an ammeter in each phase, a voltmeter on one phase, plug switches for the field circuit, and a rheostat. On one of the generator panels there are two lamps, which are used in synchronizing the machines, details of which process will shortly be given. The middle panel contains the rheostats, switches, ammeters and volt-meters for the exciters.

At one end of the board on a swinging arm is a voltmeter, connected with a compensator mounted on the back of the board. This voltmeter indicates the pressure on one of the phases, and the compensator introduces a drop corresponding to that in the main transmission circuit, so that the instrument indicates the pressure at the sub-station in Sacramento. When there is a light load and a small drop the compensated voltmeter and the voltmeter on the generator panel will read practically the same, but when there is a full load the e. m. f. on the generator must be increased until the compensated voltmeter gives the proper indication. The difference between the indications of the voltmeter connected to the



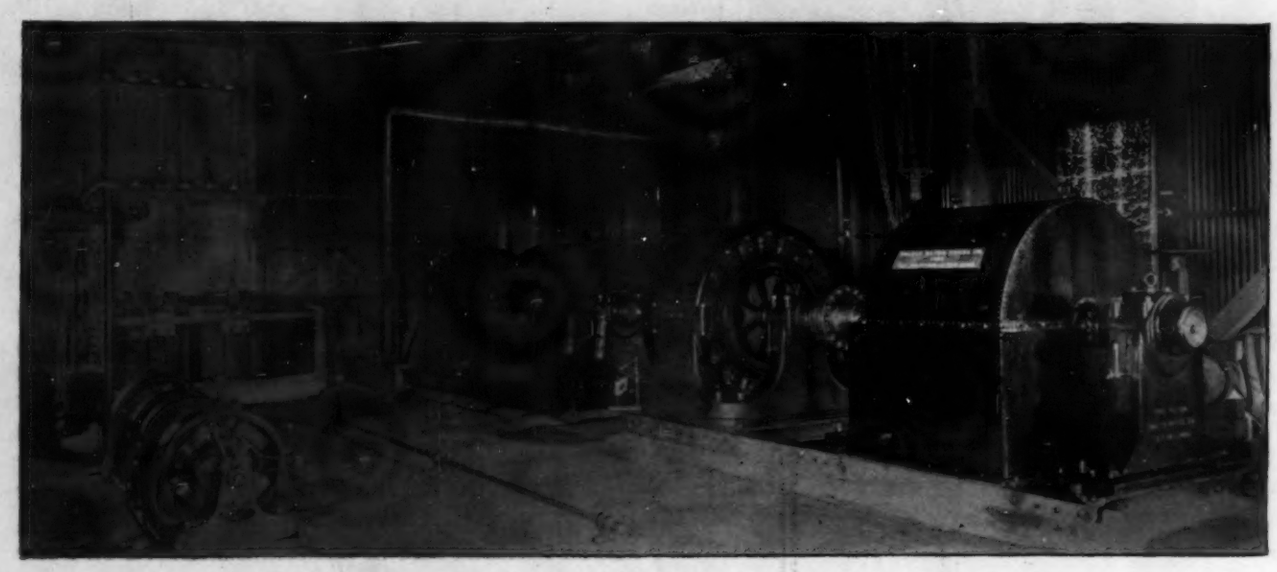
THE STATION SWITCHBOARD AT NEWCASTLE

bus bars and that on the compensator obviously gives the drop in the line.

Each generator is connected directly through the switches on the switchboard and fuses to the primary of the step up transformers which are connected to transform from two phase to three phase and deliver current at nearly 16,000 volts to the transmission line. Four step-up transformers, each of 150 kilowatts, are connected on the Scott system in two pairs of two transformers

each for the two-phase-three-phase transformation. The terminals from each set of transformers are connected through fuses directly to the transmission line.

The rather surprising fact that only 600 k. w. in transformers are used while 800 k. w. in generators are installed, is explained as follows: The water plant was intended for 600 kw., but when the machines were under consideration, Dr. Van Norden decided that it would be better to have either of them large enough to carry the whole load for a short time, in case of emergency; therefore rather than install two 300 kw. generators, it was decided to install two 400 kw. machines, having a large over-load capacity, and as the 600 kw. load only continues for a few hours in the evening, one generator usually carries the whole load during twenty-one hours of the day. The transformers are worked in parallel on both sides and one geneator therefore sends current to the whole 600 kw. in transformers.



INTERIOR OF THE POWER HOUSE OF THE CENTRAL CALIFORNIA ELECTRIC COMPANY

Both step-up and step-down transformers are oil insulated. The coils of the transformers stand in vertical planes and are spread apart to allow a free circulation of the oil between the coils, thus securing a high insulation and enabling the oil to come in close contact with various parts of the winding and convey the heat to the case by convection. Ample provision is made for cooling by air circulation without the use of water jackets or fans, but by the simple provision of vertical air tubes through the walls of which the heat is transmitted from the oil to the air.

In starting the plant some rather interesting features in regard to the synchronizing of polyphase dynamos were shown. The two generators were brought up to the same speed and voltage and after carefully synchronizing them, they were thrown together, no current flowing through the ammeters. In order to assure the electricians about the plant that there was no difficulty in synchronizing the machines, the following experiments were then made. One machine was excited to a potential of 400 volts and the other to a potential of 200 volts, and after synchronizing them, they were thrown together, the resulting potential being 300 volts, with a small current flowing through the ammeters. The field current was then entirely removed from the lower voltage machine, and the two generators still continued in synchronism. The water was then thrown off of the wheel operating the generator without field, and it continued in synchronism with a somewhat increased current flowing in the ammeters. The field current was then again applied to the machine without water and the field current was taken off of the machine whose wheel was being operated by the water, when the two machines continued in synchronism, the one without water having the field current, the one with water having no field current. Under these last two circumstances a considerable current flowed through the ammeters, but the machines continued in operation and synchronism as silently as though nothing had occurred. Under the last conditions with a full field charge on the machine having no water applied to its wheel, and no field current on the machine having water applied to its wheel, the resulting voltage was about one-half of the full voltage.

The pole line is substantial and well constructed. For five miles, redwood poles 30 feet long, 10 inches square at the butt, and 6 inches square at the top, are planted 5 feet in the ground. For the remaining twenty-three miles the poles are 40 feet long, of Washington cedar, and planted five and one-half feet deep. The distance between the poles is 125 feet. The cross arms are five feet long, with two pins and two insulators. One set of insulators is secured to the peaks of the poles, on

iron Ys, but it is stated that these ridge irons would probably be replaced by wooden pins set in the top of the pole in future installations of this kind. There is a light arm also attached to the poles for telephone wires. The three wires of the main circuit are No. 4, B. & S. bare copper, secured one to the insulators on the peaks of the poles and the others to those on the top

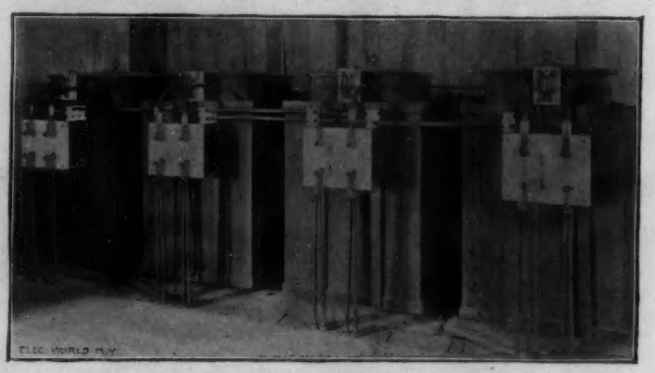
A METHOD OF HIGH TENSION WIRING

cross arm. The wires are thus placed in positions corresponding to the three corners of equilateral triangles and the inductive drop is rendered as harmless as possible. The lines are, however transposed or "barreled" at the end of every mile of wire, which was done in the interest of the telephone circuits placed on the poles below the transmission line cross arms.

The second cross arm carries the wires for local service in Placer County. The insulators were manufactured by Fred. M. Locke, of Victor, N. Y., and are triple petticoat porcelain and made to carry a current of very high potential without cracking or puncturing. They are secured to the cross arms by steel pins, thus providing a solid support for the wires. General Manager Van Norden states that these insulators have proved very satisfactory for the transmission of 16,000 volts. The line worked perfectly when the plant was first put in operation, and only a few of the 6000 insulators have developed any weakness since they were put in service. Some of these appear to have been broken by malicious shooting or other non-electrical causes. When these accidents occurred the poles were set on fire by the current, which, however, did not interrupt the service, as the pole burned away, leaving the wires hanging free. On one occasion two poles nearly a mile apart were found to have been burned, owing to faulty insulation, which allowed the current to leak from one wire through one of the poles to the ground, and back through the other pole to another wire of the circuit. Both of these poles were badly burned, but neither the attendant at the generating station nor the attendant at the sub-station knew that anything unusual had happened.*

Each end of the transmission line is protected by Wurts non-arcing metal lightning arresters. There are six choke coils connected in series in each of the three wires and from the line at the junction with the coils, there are spark gap paths to the ground, through which lightning discharges can pass. No resistances are introduced in the ground circuits, so the lightning discharge encounters nothing except the spark gaps on its way to the earth.† At the sub-station at Sacramento the current is received on a high tension switchboard panel, by which it may be delivered to either or both of two sets of step-down transformers.

Special precautions were taken in the design of the fuses and switches for use on this high tension circuit to secure safety, as well as reliability and simplicity. The fuse terminals are enclosed in hard rubber fittings, which are supported on high tension triple petticoat insulators. The fuse is of fine wire, a foot or more in length, enclosed in a rubber tube and the contact between the fuse and the terminals is made by a screw which is entirely covered by a hard rubber cap. The high tension switchboard consists of a marble panel, with receptacles at the middle for the line terminals, and at the top and bottom for the terminals of the circuits to the step-down transformers. Connection between receptacles is made by plugs connected by flexible cable. The receptacles are entirely enclosed in hard rubber, so that there are no contacts exposed at any time, the plugs and the cables joining them being thoroughly insulated. Detachable wooden handles are used for handling the plugs when they are to be inserted or withdrawn on a live circuit, and an insulated floor or platform is arranged, on which



THE RAISING TRANSFORMERS AT NEWCASTLE

the attendant stands when making connections on this switchboard. To prevent accident in case of a breakdown in insulation, or dampness on the surface of the

*For additional details see Van Norden on "The Line Insulation of 16,000 Volts" in the Journal of Electricity for September, 1897, Vol. IV, No. 6, page 113.

†See Sutcliffe on "Lightning and Long Transmission," Vol. V, No. 2' page 40, and Wurts on "Sutcliffe's Queries," Vol. V, No. 4, page 76.

plugs and handle, a special device is used to effectually protect the attendant from the current. Near the middle of the handle there is fastened a chain, which is connected with the ground, or the support of the floor on which the attendant stands. The latter is therefore thoroughly protected, as the escaping current has two paths between the terminals of the chain, one through the low resistance metal chain, and the other through the wooden handles, the operator, and the platform, the resistance of the latter compared with that of the chain being so great that the attendant is effectually protected. No difficulty was experienced in pulling out the plugs when the secondary of the six 75 kw. transformers was short circuited. The short circuit, which was between the transformers and the low tension fuses, was of such a nature that the high tension fuses did not blow, which it is claimed, illustrates conclusively the effectual nature of this method of breaking high tension currents.

In the sub-station there are two sets, each consisting of three pairs of 75 kw. step-down transformers, which receive three-phase current and deliver two-phase current at 2200 to 2400 volts to the bus-bars of a distributing switchboard. This switchboard is provided with throw-over switches, by which either current may be thrown on either phase desired; and with fuses enclosed in lignum-vitae holders, as well as containing ammeters and voltmeters. The 2000-volt distribution is similar to that from ordinary 2000-volt dynamos. The circuits are supplied with standard transformers for reducing the current from 2000 volts to 100 to 200 volts, as may be desired. Transformers are used for ordinary lighting work, and for the supply of two-phase motors, and also by simple combinations for the supply of three-phase motors.

In the sub-station are two 50 hp. induction motors, direct coupled to 60 light, Westinghouse separately excited, direct current, 9.6 amperes, series machines for supplying arc lights. These induction motors are supplied by two 75 kw. transformers, which deliver two-phase current at 2000 volts.

Special attention is called to the use of a new protective arrangement, with which the high tension transformers are all supplied, namely, the non-arcing metal spark gap protector. This protector is connected between the low tension coil and the ground, and prevents the great rise of e. m. f. between this coil and the ground, which might occur either in the case of a breakdown of the insulation between the high and low tension coils in the transformer, or which might be caused under certain conditions by static induction between the two windings.

The protector consists of a spark gap similar to that in the well-known non-arcing lightning arresters, one side of which is connected to the ground and the other side to the middle point of the low tension winding. The normal e. m. f. of the low tension coil is not sufficient to cause sparking across this gap, but in the case of undue rise of e. m. f. the current jumps across this gap and connects the coil to the ground, thus affording protection from the dangers which would arise if the low tension circuit were at a great difference of pressure from the ground.

The plant has been in regular and successful operation for over a year, during which time there have been very few shutdowns, and those for brief periods only. The plant is shut down for a few minutes every Sunday morning for a general inspection and cleaning of the apparatus and the plant attests the perfect success attending the transmission of power for a distance of nearly 30 miles, involving the use of nearly 6000 insulators on a 16,000 volt circuit.

The Central California Electric Company was organized by Mr. Warren Van Norden, President of the South Yuba Water Company. The work is in charge of General Manager Dr. Chas. Van Norden, and the electrical features of the transmission are in the charge of Mr. E. W. Sutcliffe, superintendant and electrical engineer for the Company.

Thanks are due to Mr. R. S. Masson, electrical engineer of the San Francisco office of the Westinghouse Electric & Manufacturing Company, and to the "Electrical World" for information and illustrations given.

Gas

A FRAUD UPON ELECTRICITY.

By Sidney Sprout.

HAVING been, during the past few years, the consulting engineer of several electric lighting systems that are operating gas works, I concluded, while in the East a few weeks ago, to make a personal investigation of the merits of a new gas process by which it was claimed that a good fuel and illuminating gas could be made at a remarkably low cost. It appeared to me that if I found the process to be as represented it would be to the great advantage of some of my employers to adopt it. If not, such information as I gathered would doubtless be of value to me in a professional way.

I confess it was with some misgiving that I took the matter up because of the claims made in a circular advertising the process, which stated that it was an "electric process" for manufacturing gas. This does not mean that I thought the process would be without merit, because it professed to use electricity, but the wording of the circular referred to excited my suspicion. At the beginning it stated that by this process could be made a fuel gas equal in every way to natural gas at a cost of less than 10 cents per thousand cubic feet. My experience had been that no fuel gas could be made at so low a cost. The pamphlet then went on to state "The invention . . . . . is a pioneer in a new field, namely, the using of electric action obtained inside the generators for the purpose of breaking up the component gases which go to form a commercial fuel gas, all former processes having depended upon the action of heat to accomplish this purpose. But heat does it only partially, while electric action does it completely. The successful introduction of this powerful agent into the manufacture of gas for fuel and light, has given similar astonishing results to those obtained in so many other lines of discovery and improvement by its means." I could not believe that the component gases of a fuel gas could be

completely broken up by "the using of electric action." I looked up the patent, but this added to the mystery as will be explained.

The pamphlet also stated that the Kalmazoo Heat, Light and Power Company of Kalamazoo, Michigan, was manufacturing gas for fuel and lighting purposes by this process, and so I went up to that city from Chicago where I found that the plant referred to was using what has long been known to gas engineers as gas made by the Hall Process, which is based on patent No. 494,200, issued to T. G. Hall and dated March 28, 1893.

About the middle of July, 1891, the Michigan Fuel Gas Company started a plant using the Hall process in Grand Rapids, Mich., but the company failed and the apparatus was moved to Kalamazoo, where, after necessary alterations and additions had been made, it was set up as a plant of the Kalamazoo Heat, Light and Power Company. The apparatus as erected at Kalamazoo, consists of a generator or combustion chamber into which coal and oil are injected and which is supplied with a strong blast of air. From the generator the products of combustion were led to the mixing chambers, into which steam was introduced. It is in these mixing chambers that the so-called "electric action" takes place and my particular attention was given to this detail of the apparatus. The mixing chambers contain what were termed "receptacles" of copper and iron and it was represented that these receptacles, being of "opposite electric polarities," possessed the ability to break up the component gases of fuel gas. No external source of electricity was applied to the elements or receptacles, but instead the so-called electric action was attributed to the thermo-electric powers of copper and iron under heat. From the mixing chambers the gas was carried on through the usual condensers, scrubbers and purifiers to the gas holder, the product being a form of Dowson gas which is one of the lowest forms of producer or fuel gas. I learned subsequently from a report of an engineer of the company that the gas had a specific gravity of 0.913, which makes it almost as heavy as air. This is a disadvantage in that such a heavy gas is unstable when burning, and a comparatively slight draught of air blows it out. The gas is used only with incandescent gas burners of the Welsbach type, as when it burns in an ordinary burner it gives a pale blue flame of low candle power. It is, therefore, distinctively, a fuel gas, which, however, gives satisfaction as an illuminant when burned in incandescent gas burners.

Right here I think it is but just to state the opinion that the officials of the Kalamazoo plant as well as those who are interested in promoting the process, are sincere in the belief that electricity is an indispensable factor in the process; that it is generated in material quantities in the mixing chamber, that it decomposes the component gases into a nascent state from which they reunite into a perfect gas, and that taken altogether the process is one of unusual merit. None of them are conversant with electrical theories or practices, and that their electrical reasonings are at least fallacious is not to be doubted.

The question which is of immediate interest is naturally in relation to the so-called electric action of copper and iron, which are electrically insulated from each other and are so arranged that they are exposed to the heat of a gaseous mixture consisting of steam and the products of the combustion going on in the generator. The receptacles were of a cup-shaped appearance arranged in rows along the fire bricking and in reply to my inquiries I was assured that an electric action took place between the gas and the receptacles, as such had been conclusively demonstrated by the fact that on leading wires out from the iron and copper elements to a galvanometer, the presence of electricity could be detected on the galvanometer needle, and in fact the needle could be made to swing violently. In making these experiments one of the wires leading from the galvanometer was connected to the copper pieces of several of the receptacles, while the other wire was connected to the iron parts of the receptacles, just as an electrician would couple up several cells of batteries "in parallel," or "in multiple-arc."

The movement of the galvanometer needle in this experiment was accepted as proof that the iron and copper receptacles, being of "opposite electrical polarity," excited a decomposing influence on the gases that were forced by the blower to pass through the mixing chamber in, about, and between the receptacles. I could get no further information than this as the plant was in continous operation which prevented my making a close examination of the receptacles. I saw and heard enough, however, to convince me that the electrical features of the process were spurious.

The statements made in a preceding paragraph are alone sufficient to convince any well-informed electrician of the imposition that the Hall process has practiced upon the patent office and upon the general public; but while the electrician comprehends the enormity of the imposition at a glance, the general public does not understand it all and risks its money in an enterprise which is bound to fail and, having failed, the public will certainly blame the electrical industry for it. It is in order that fraud may be exposed and in the hope that unsuspecting capital may not be sunk in spurious processes of a so-called electric nature, that I have concluded to contribute this article.

Let us have a thorough understanding of the situation as presented by the claims of the advertising pamphlet, by the specifications of the Hall patent, and by my own observations of the Kalamazoo plant. The inventor does not confine himself "to any particular receptacle, or any particular way of insulating materials of opposite polarity," but states that he has "found that the materials of opposite electric polarity may be contained in receptacles arranged in the following manner: that is, one of such materials contained in a receptacle, as a porous cup of refractory material with a second porous cup of refractory material imbedded therein, such second cup containing the material of opposite polarity." Claim 6 of the patent specifications states that "the materials of opposite electrical polarities" do not come "into electrical contact with each other." These statements show it to be the intention that the materials of opposite polarity are to be insulated from each other, that is, they are not to be in actual contact with each other, metal to metal; this is a point that should be borne in mind. I was informed in Kalamazoo that these materials were of iron and copper, and it is so stated in the specifications. From a thermo-electric standpoint, these metals are "of opposite electrical polarity" and morover, the elements, as the materials may more properly be called, are exposed to the high temperature of the mixing chamber which is, I judge, in the neighbood of 1500 degrees Fahrenheit.

...

It is well established in electro-physics, that if two dissimilar metals are brought in contact and their junction is heated, a current of electricity will flow from one to the other, the direction and amount of current flow vaying with the metals used and with the conditions of temperature, Copper and iron are of opposite electro-thermal polarity and they posssess thermo-electric prop-

perties to a fairly well marked degree, but no electric action can take place between iron and copper or between any other dissimilar metals unless the two metals are in actual contact with each other, or in other words unless they are not insulated from each other. The Hall patent particularly states that the metals constituting the receptacles are not in electrical contact one with the other, hence if they are in a condition which the patent states, it is a physical impossibility for the copper and iron elements to generate electric action by thermo-electric or any other means. If the two metals are in electrical contact, an electrical action may take place, but in any instance the electric potential will be exceedingly minute. There is no possibility that a thermo-electric contact may be established between the elements by coatings or impregnations of carbon, and it is equally impossible for an electrical contact between the elements to be established through the surrounding gases, which are at high temperature and of almost infinitely high resistance.

Now let us see how it is possible for an indication of the presence of electricity to be given by the needle of a galvanometer, as was stated to be the case at the Kalamazoo plant. If a piece of copper wire be connected to a bar of iron and the bar be placed in a forge and heated, an electrical potential will exist between the free ends of the bar and wire, and if they be connected to a galvanometer, its needle will manifest its presence on the galvanometer, as was stated to be the case at the Kalamazoo experiment, where the electrical indications obtained on the galvanometer were sufficiently pronounced to hoodwink almost any non-electrical man into the belief that electricity was used in the process. Hardly a plant of any nature in any branch of industry can be found but that will, on a similar test, show the presence of these minute currents of electricity in one portion or another, and so sensitive are the different processes of electrical detection and measurement that even a wire stretched in the air and swung above the surface of the earth will generate enough electricity by cutting the magnetism of the earth to deflect the needle of a galvanometer. The presence of electrical indications under conditions parallelled in the receptacles used in the Hall process is a most commonplace occurrence that has long since lost the element of novelty to electricians.

One further point before concluding: The principal feature of the Kalamazoo process is claimed to be "the using of electric action obtained inside the generators for the purpose of breaking up the component gases which go to form a commercial fuel gas."

The only report that has been published on gas produced by the Hall process, and which is referred to in detail in a descriptive circular of its promoters, is that of Van Denbergh, which shows that 69.1 per cent of gas made by the Hall process consists of oxygen (0.5 per cent), hydrogen (13 per cent) and nitrogen (55.6 per cent)—this latter being inert and dead and utterly useless in any commercial gas. These three gases are free elements and cannot be decomposed or broken up in any way. The remaining component gases are carbon monoxide (8.9 per cent), carbon dioxide (6.6 per cent), marsh gas (8.8 per cent) and illuminants (6.4 per cent). Electricity has absolutely no distinctive effect whatever on gases whether they be as a free element or in chemical combination—the word distinctive being used in the sense that a current of electricity will exert no influence on gases which the agency of heat will not do. The promoters of the Hall process state furthermore that this breaking up of the component parts of the mixed gases has hitherto been accomplished by the action of heat which "does it only partially, while electric action does it completely." The mixing chamber at Kalamazoo becomes very hot, and if other processes depend upon the action of heat to break up the component gases, the Hall process depends on heat to break up the gases as well as do the other methods, and an ingenous adaptation of a most simple phenomena of thermo-electrics has afforded a subterfuge by means of which the process may be rendered more attractive to capital through the devising of a pretext under which it may be called "an electric process."

Whatever may be its merits otherwise—and in my judgment it has no particular ones—and however sincere its promoters may be, I am convinced that there is nothing electrical about the process, and that it is from an electrical standpoint, at least, a bald, rank fraud.

Pneumatics

COMPRESSED AIR AT THE GWIN MINE.*

By E. A. Rix.

CALAVERAS county possesses not only one but both of the largest air compressors in the State of California. The first one was installed at the Utica Mine, at Angels Camp, and consists of four 18x24-in. air cylinders, placed tandem to each other and driven from a water wheel under a head of about 565 feet. This compressor furnishes air for the rock drills and pumps of the Utica Mine.

The second compressor has been recently installed at the Gwin Mine, in Calaveras county, and is an extremely interesting and economic installation of compressed air for mining purposes.

The situation of the Gwin Mine is such that it naturally suggested a power plant either electrical or compressed air. The Gwin Mine is situated in a canyon, about 5,000 feet distant from the Mokelumne river and 425 feet vertically therefrom.

The mechanical opeations at the Gwin Mine are actuated by water power from a ditch running on the hillside above the mine, at an elevation of somewhat over 400 feet. This water drives the 40-stamp mill, and the hoisting works at the new shaft, and supplies such other uses of the water as are necessary around the mine, amounting in all to about 230 inches.

The Gwin Mine shaft is a new vertical shaft, about 1450 feet deep, and it is about 100 feet distant from the old shaft, through which a veritable bonanza was taken by the early day miners.

The drifts from the new shaft have approached dangerously near the old workings, and I believe in some instances the new drifts are beneath the old mine which has been full of water for the last twenty years.

The desirability of draining this mine, both for matters of safety, and to turn it into an air shaft, brought forward the problem of utilizing the tail-water running from the various workings about the mine down the canyon to theMokelumne river. It was evident that here was a splendid opportunity to pick up a considerable amount of power with the simple cost of the investment in the plant. The 230 inches of water falling down to the Mokelumne river has a potential of not less than 230

*From the Golden Jubilee edition of "The Mineral Resources of Calaveras County."

h. p., just about the same amount that was used around the mine. After taking estimates and bids and considering the situation in general, the Gwin Mine Development Co. decided upon compressed air as being the most flexible power for the purpose intended, and the installation has been completed in what I believe to be a thoroughly satisfactory manner to the company. The water is first caught up from the mill and hoisting works in a large redwood tank, holding 75,000 gallons, situated just below the tail water of the mill. From this tank a 15-inch steel pipe conveys the water 4500 feet to the power-house, situated on the bank of the Mokelumne river. It is here applied under a pressure of about 181 pounds to the square inch upon a Pelton water wheel nineteen feet in diameter, making eighty revolutions per minute at its normal speed.

THE GWIN MINE HOIST.

The compressor is the same size as the Utica, viz., a Rix horizontal compressor, having four 18x24 air cylinders. The last two cylinders, however, have not been placed in position, the work at present simply requiring the use of the first two cylinders. The air is compressed to about 85 pounds to the inch and carried through 6500 feet of 6-inch steel pipe to the old shaft, following the old pipe line grade. At the old shaft the air enters two large air receivers four feet in diameter and twenty feet long each and is distributed from there down the shaft to the pumps, and to a double 10-inch hoist which was installed at the same time for the purpose of clearing out the old shaft.

The water from the old shaft stood within a few feet of the surface. A duplex sinking pump, of a capacity of 150 gallons a minute, was put to work as soon as the compressor plant started, and at the present time of writing the water has been lowered considerably below the 600 foot level, and the large compound station pump is about in position and ready to start. This compound pump will handle all the water of the 600 foot level, and the sinking pump will follow along down the shaft delivering water to the 600 foot level. At the 1200 foot level there will be another station pump from the upper station to handle the water, which accumulates below the upper station.

The pumps started on or about November 8th of last year, and have been continuously working during these past ninety days, and the ease with which the whole work has been accomplished and the small amount of power it comparatively has taken, should be good evidence that compressed air is the proper thing for this character of work.

The compressor has been making an average of from 30 to 45 revolutions, increasing gradually as the sinking pump lowered the water. At the same time the hoist has been doing the work of clearing out the shaft, lowering new timbers, men, pipes, pumps, etc. There is an ample quantity of power, generously applied, and there has not been in connection with this work the usual delays, mishaps and disappointments.

It is the intention of the mine to reheat the air in the compound pump at the 600 foot level, and also to reheat the air for the hoist, or for any other work it may be compelled to do, so as to make the matter an economical one at the time when the compressor reaches somewhere the limit of its capacity. This, however, will be some time in the future.

After the old shaft is drained and connection made with the new shaft, it will be used as an air shaft and

compressed air will be used to run the main hoist of the mine, thus saving the water now being purhased for that purpose. There is an appreciable loss from one end of this system to the other, the gauges registering practically the same. There is, however, a slight difference due principally to the difference of elevation.

The economic power is not that power which shows a high rate of economy for a two minute measurement; it is the power which costs less for a 24-hour service wherein a proper credit has been given for its utility. No power can be made to yield a high economy until it is properly used. A tangential water wheel must be speeded to 50 per cent of the spouting velocity of the water in order to give the 85 per cent efficiency claimed by the builders, and it would be as sensible to judge of the economy of this wheel when running at 25 per cent of the spouting velocity as it would to judge of the economy of compressed air where it is not used expansively. Unfortunately, utility demands the service of air at all prices and hazards, and while the results have justified the means, still a little patience and investigation might result, where the inauguration of a compressed air plant is concerned, in obtaining a plant that, over and beyond the question of utility, would be extremely economical. Perhaps it is because air, as we find it in Nature, is so abundant and free, that it suggests the carelessness with which it is used in ordinary operations, but certain it is that if more air is wanted underground, the compressor is speeded to all it will stand but little thought is given to stopping the waste in the air being used. It is only recently that mine owners are beginning to ask about economic machines for the use of compressed air.

In the installation of a compressed air plant, the duty of the purchaser does not end in selecting a compressor which he believes to be best adapted for his purposes His duty really begins when he commences to install it and to use the air which it supplies. There cannot be a difference of more than ten per cent between the relative economics of most of the compressors manufactured by the standard builders throughout the United States, but there can be a difference of more than this amount made in simply piping the compressor to the receivers, if it is done improperly, let alone sending the air two or three thousand feet underground.

Too much attention cannot be properly given to the installation of the plant. A little less money spent on the compressor, and a little more on the receivers would often give a better power result.

It has been considered good practice until recently, to establish with a single 10-inch compressor an air receiver 3 feet in diameter by 12 feet long, holding about 85 cubic feet, but this is far too small as a general rule, and with this compressor there should go a receiver about 4 feet in diameter by 20 feet long, holding 240 cubic feet which is about three times the former capacity. The difference between these two receivers would enable the 10-inch compressor that is limited ordinarily to driving two rock drills, to have a capacity for about three.

It is an important thing to have large conduits throughout the mine, and down the shaft, and no one-inch pipe conveying air.

A TRESTLE ON THE COMPRESSOR LINE—GWIN MINE.

The difference in economy between using air cold and reheated is about 50 per cent. This tells its own story, and if by using air cold one has nearly reached his power limit, by properly reheating it can be increased to that extent.

Many suppose that reheating cannot be done underground. A very little investigation into the matter will show that there are few mines in the State, where underground reheating cannot be successfully installed. There are mines in this State reheating at 1600 feet, and at a thousand feet, and many below five hundred feet. This reheating can either be done with oil, or coke or wood, depending entirely upon the nature of the air currents in the mine. The users of compressed air for pumping in mines have been compelled to employ the direct acting steam pump, which is an extremely wasteful engine, because the compound pump would freeze up. In the present method of reheating, compound pumps can easily be employed, saving fully 50 per cent of the air used for actuating them.

The use of compressed air in mines is constantly expanded. A very interesting and novel proposition is now being demonstrated by the writer, for one of the principal mines in this State, on the subject of mine haulage. Compressed air motors will be installed on the 2,000, 1,800 and 1,600 ft. levels of the mine, to haul trains of ore cars from the face of the workings about one-half mile to the shaft, reducing the expense of hauling, from twenty-five cents per ton to five cents.

Electro-Economics

CENTRAL STATION SWITCHBOARDS.*

By F. A. C. Perrine, D. Sc.

THE switchboard in a central station should be considered not only as a means of distributing electricity, but also as a central point from which influence extends which modifies the character of the work done throughout the entire plant as well as the care devoted by the workmen to the maintenence of the station.

In every plant there is some such central point of influence, which is found in the part of the machinery to which the attention of both technical and nontechnical eyes are attracted. In manufacturing plants this central influential point is found in the engine room, and manufacturers so well recognize its influence that some years ago the cotton manufacturers of New England determined that one per cent of the capital stock of the Company expended in the equipment and proper adornment of the engine room was a profitable investment, as improving the care devoted by all the employees to the machines under their charge. The engineer and his set are the aristocrats of a manufacturing plant and if these men take pride in the appearance of their machinery all other workmen will emulate them and the general efficiency of the plant be increased.

In a lesser degree the switchboard of a central station modifies the action of the dynamo tenders as well as the linemen and lesser employees. If poor work is done in wiring the switchboard, the circuits of the dynamo room will receive little care and those outside the station will be in a worse condition, whereas no one would be willing to have a poor piece of work exposed near a carefully arranged and well wired switchboard, and the care taken in the occasional work done on station circuits will be reflected in the results obtained on the outside circuits. In consequence of this fact the appearance of the switchboard warrants an expenditure which seems almost lavish.

Extravagance is not necessary to obtain the best results at this point, as indeed extravagance is nowhere allowable in a plant, and hence by "lavish expenses" is not meant the use of marble carvings or other unnecessary decorations, but that the switchboard should be of such a character that it can most easily be handled, most readily kept in good condition, and show the best result for the pains spent in its maintenance. If this is true, the workmen are not sparing in their pains, while if extravagance is indulged and unnecessary care is required for the proper maintenance of the switchboard and if instruments are installed whose reading is not necessary for the proper manipulation of the plant, gradually an increasing disregard for the value of all instrument readings will creep in. Thus it does not pay to purchase for installation on the board every new-fangled piece of apparatus on the market, nor to foolishly decorate its surface with brass castings or marble cornices, although it does pay to use such materials that the apparatus connected with the board is not easily put out of order and that leaks through the board will be impossible. It also pays to spend an extra amount of money in making the relative appearance of the board and of the instruments such that the instruments are most readily selected and read from a reasonable distance,—therefore, in general we may say that the construction of the switchboard will be the most beautiful when it is reduced to the simplest possible terms and the materials used are those most readily kept clean when the instruments installed are the most accurate obtainable and their arrangement on the board the best for rapid and safe handling,—even when operating during periods of accidents and in the midst of possible danger.

On account of this last point, the location of the board itself is also not only not a matter of indifference, but is of supreme importance, for the proper choice of location facilitates all work about the board and extends the sphere of the good influence already spoken of. This means that a properly located switchboard is not hid in some ill-lighted corner, but is placed as prominently as possible, and especially it must be so located that it is not in the way of danger from flying belts or short circuited machines when the effects of accidents are being corrected. This has lead in many cases to placing the boards in galleries where a separate switchboard attendant is made possible by the size of the station, and as such a location makes it easily possible to insulate the floor space before and behind the board.

This matter of floor insulation is one that is often neglected, as the effect of nervous fear of the slightest shock during the time that risky changes are being made is often not appreciated by the switchboard designers. In everyday working a slight shock may not interfere with the composure of the workmen, but when handling heavily grounded circuits carrying currents at high potentials, a workman is apt to become nervous under the slightest cause for discomposure.

In general the requirements for a satisfactory switchboard have been stated and it is now necessary to consider particulars in constructions. Taking up the requirements separately and examining the commercial possibilities of fulfilling them in the best manner, we find that in the matter of material of the board itself, choice is very limited. Solid wood boards are to-day altogether discredited on account of their easy inflammability, while skeleton ones are only to be considered as meeting the needs of the smallest and cheapest plants. The material of the board, to be fire-proof and at the same time free from possibility of leaks, brings us to the consideration of only slate, marble, glass and porcelain. Lava, or other close grained stone, might indeed be available for use, were such stones to be found regularly in the market and obtainable in satisfactory quality and sizes at a reasonable price—but at the present time these conditions are not fulfilled. Slate was at one time the favorite material for the construction of switchboards, on account of the fact that no other stone is as readily drilled and worked, nor can any other stone be found which is so cheaply obtained in large flat slabs—but unfortunately slate is a material which is very variable in character, containing in some cases large amounts of

* A Paper read before the San Francisco Convention of the Pacific Coast Electric Transmission Association, February 15, 1898.

partially reduced metallic oxides, which lower the specific resistance of the material so far that it may become dangerous for high potential work, and in any case slate is so porous that it is not thoroughly safe to use without the European precaution of thorough impregnation with an insulating wax. This thorough impregnation is a matter of considerable difficulty, on account of the fact that the slate will frequently decrepitate on being heated to the necessary temperature, and in consequence the expense of impregnated slate is very much beyond that of the untreated material.

Porcelain is a material upon which we rely so much for insulation in difficult places that one would naturally expect to find some use of it in switchboard construction, but up to the present time no porcelain manufacturer has succeeded in making flat slabs larger than about ten inches square, and no one has carefully undertaken the construction of a switchboard framed in metal or wood and faced with porcelain. Such a construction might indeed be a cheap and thoroughly satisfactory one, but there are still a number of difficulties to be encountered which can be undertaken only by a switchboard manufacturer. Large glass slabs would be admirably adapted to this service, but unfortunately this material is too difficult to work and in consequence the expense of a glass switchboard properly drilled for the instruments and connections would be very great indeed.

On account of the difficulties which have been met in the employment of every other material for switchboard construction, marble has come to be considered as the standard material for this service, and if the marble be obtained free from metallic veins, it is entirely satisfactory. It has the advantage of a sufficient strength to stand whatever shocks may come from throwing switches. It is not porous to any appreciable degree and it may be found in many colors, so that it is easy to obtain marble in which the instrument facings may form a sharp contrast and be readily read from all parts of the station. The relative advantages of native and European marbles involves not simply the question of beauty and evenness of texture, which are the points considered in marble carvings, and statuary work, but also the question of an absolute freedom from metallic veins, which is a property of the pure white Italian marble. Furthermore, no other marble is so easily kept clean, nor is any other found with which the instruments give so sharp a contrast, and, where the expense is not prohibitory, the use of this marble is to be favored, but at the same time, should its cost be very great in comparison with that of native marbles, a careful consideration of the color of the instruments and the instrument scales should result in contrasts which would be sufficiently striking for the instruments to be easily read and manipulated.

After the material of the board itself, the switchboard circuits are the most important item in construction, and the most important question in the consideration of circuits is that of the proper character of the insulation to be employed. In this service, everything should give way to fire protection, the weatherproof character of the insulation being entirely a secondary consideration. These circuits when definitely located are rarely laid flat along the surface of the board, and never touch one another, nor is there likelihood of the switchboard ever being wet with water, and in consequence any insulation which gives satisfactory protection against damage from accidental contact will be satisfactory, if at the same time it is impossible to ignite it. Sparks may fly at any time from switchboards, and always do fly at some time, whereas at this point a conflagration which at any other part of the system might be considered as insignificant, is apt to result disastrously. Slight switchboard fires have wrecked dynamos and engines and have even consumed large plants. Indeed, the effect of a small switchboard or station fire need not be emphasized to those who remember the destruction of the Brush station in New York and of the station at Hartford, Conn., and the recent destruction in Philadelphia of the Traction Company's plant by a short circuit at a dynamo. For this same reason care must be taken in the location of the circuits both on the board and those leading to the board. This is especially important in high potential working, for in this service heavy long arcs may occasionally be drawn which are attracted by some of the wires, and in consequence if the wires leading to the board, or the wiring along the board be carried over switchpoints from which long arcs may be drawn there is great danger of the wires themselves catching fire, and even of their being entirely fused.

While therefore, the fireproof character of the insulation for a switchboard and for station circuits is of the first importance, it must not be forgotten that it is everywhere advisable that all parts of high potential circuits should be either well insulated or so hidden that accidental contact is impossible. More than one man has been injured at a high potential board by stumbling and trying to catch himself, consequently it is not only sufficient to place the switch-points behind the board, so that the switch handles may be safely worked, but it is also necessary to protect these switch-points in such a manner that rapid connections behind the board may always be performed without danger of contact with deadly circuits. This necessity was fully recognized by Mr. Ferranti in all of his high potential work, and it is to the credit of his foresight that so few accidents have occurred in plants that he has installed.

In low potential working great insulation of switchboard circuits is not necessary and hardly even advisable, but it is rather necessary that low resistance and good lines and good contacts at all junctions should be assured. Low resistance now means not only a large area of copper, but also good heat radiating surface, so that the wires may remain at their normal temperature even when carrying large amounts of current. Various experimenters have proved that a black surface will radiate heat twice as well as a white surface, and in consequence the common practice of polishing and lacquering bus bars and switches is not only an extravagance, but a bad practice from an engineering standpoint.

As regards the manner of the switchboard wiring, it is at the present day hardly necessary to insist upon careful workmanship, but if the board is to be considered as the influential point in the station even more than common attention should be paid to this question, and especially it should be insisted that all work on switchboard circuits, whether intended to be only temporary or for permanent use, should be done in the best possible manner,—and if this be insisted upon the busy superintendent will find at least one point at which he can carefully observe the manner in which the linemen are accustomed to do their work. Furthermore, temporary switchboard circuits imply station changes, and station changes bring with them a period of possibility of accident greater than usual, which accidents must, mainly be corrected at the switchboard, where a few temporary and badly run wires might multiply little station difficulties to a disastrous extent. Furthermore, it should not be forgotten that temporary work often remains for years in the busy central station.

The instruments themselves show perhaps the reason

for the existence of the switchboard, but are here put down in the third place of importance, because errors likely to occur in the choice of instruments are not so important as errors commonly made in the choice of switchboard material and in the construction of switchboard circuits. In aiming at simplicity of design and ease of working about the switchboard the principle may be laid down as regards to instruments that no more should be installed than are necessary for the manipulation of the plant and for obtaining a daily or hourly log report on its operation. This implies perhaps a few more instruments than are absolutely necessary for the manipulation of the plant. At the same time the log gives the only true data for an engineering test of plant operation. Tests under test conditions always give results more or less ficticious. Every man is, as the saying goes, at "test pitch." He desires to show his maximum efficiency, and the maximum efficiency of the machines with which he is working, and in consequence the occasional test of a plant will give results better than those obtained from actual service. On the contrary, the log gives a report by means of which may be detected those little leaks which eat into the profits and which indicate a falling off in the efficiency of either men or machines. No good man will neglect repair or fall off in efficiency if he knows that he is continually checked up by a log, and also wheels and bearings may become disarranged without giving other notice than can be found in such a test report. It is indeed true that every station superintendent is not capable of properly interpreting a log, but the best man is without data for careful reasoning who has not such a report at his command.

Whatever instruments may be installed their arrangement is of the greatest importance, but if the general criterion be applied to all switchboard designs that all switches and rheostat handles and other apparatus of manipulation be placed at convenient levels for handling and that all related instruments be grouped so that they may be easily observed the best results will be obtained. These ideas are so obvious that it may seem strange to bring them forward, but it is even stranger to find that they are so often disregarded. Large and expensive boards are often found where the same man cannot at once manipulate a machine rheostat and observe the effect he is producing upon the instruments. Much of this ill arrangement comes from a mistaken idea that the resistance boxes must be located on the switchboard and within a few inches of the rheostat handles; and in consequence more consideration is devoted to economizing the space on the board than for the convenience of those who are called upon to manipulate the apparatus. Not only may rheostats be operated through the medium of a sprocket wheel and chain, but also it is possible and not necessarily expensive to locate switches at a distance from the operating handles, and if these points be taken into consideration, the excuse for inconvenient location of related apparatus disappears. A worse practice than this, however, consists in the placing of fuses, circuit breakers and switches likely to flash, at points where they become elements of positive danger to the operators or to the circuits. Here again it is necessary to insist on the fact that the switchboard must often be rapidly manipulated and the service saved at the risk of some personal danger, which cannot be encountered with fuses and circuit breakers and switches flashing in the workman's face, and sending up arcs which burn off his circuits. This question of the separation of instruments and the handles by which they are worked reduces some of the difficulties of switchboard location and some of the dangers connected with high potential working, for by these means it is not only possible to install a safe board which can be placed far away from a wall by placing the switches to the rear of the board and the handles in front, but it also allows the location of all apparatus vertically above the manipulating handles, and at the same time, on the face of a tall board placed up against a wall. If this is done, however, the board must be tall enough to allow a gallery for the manipulation of circuits, and the old custom of making circuit changes from ladders should not be contemplated.

Finally the question of the proper location of a switchboard is perhaps the most perplexing of all the points in the station design. The board may be placed anywhere, and for this reason there is a certain temptation to disregard its location in the original plan of the station, but if it is to be considered as a center of influence, and if it is to be considered as a point at which rapid changes can be made which will certainly preserve the service in spite of accidents to lines or machines, it must be placed prominently and so prominently that all work about it may be easily seen as well as so prominently that the station attendants may watch it for their guidance. The board should then be clearly lighted, the space about it on all sides should be sufficient for careful and rapid work, but above all it must be carefully surrounded by a space insulated from the ground. The fact that the switchboard is set on edge and towers into the air does not warrant the assumption that it does not need a clear floor space about it. Neglect of this consideration has often resulted in unreliable service, which transmission plants cannot contemplate. With the introduction of long distance power transmission the time has passed for the occasional temporary interruption of service, and until machines and lines may be built which will never fail, the switchboard will remain the one point from which it is possible in almost all events to maintain absolute continuity of service.

There is nothing particularly novel in what has been said here—nothing which all have not known from their studies or from their experience, and if there is nothing novel, there is all the more reason that these suggestions should be emphasized, for they are not always carried out in stations which are considered well designed. Furthermore, the merit of a suggestion does not consist in its novelty, and we are already injured in our electrical engineering by a too great striving after novelty in much of the designing which we meet in heavy practice, and it is here intended to call attention to only some of the points of good engineering, which have been proved to be good and necessary by the experience of the past in the central stations which have already been erected and which may serve as the best guides for the construction of transmission plants, which differ from the common central station principally in the demand for absolute continuity of service. Transmission plants, to be entirely successful, must be so constructed that the service will never fail, and for such absolute continuity of service it is necessary to consider the switchboard even more thoughtfully than the careful engineers of the past have considered this vital element in the generating station and the sub-station.

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EDITORIAL.

CONCERNING ELECTRICAL CHARLATANS.

The article contributed by Mr. Sidney Sprout on "A Fraud Upon Electricity," appearing on another page, suggests the bounden duty of electrical journalism to denounce in the strongest terms every effort that may be made by schemers who so often succeed in inducing capital to invest in so-called theatrical enterprises that really have nothing electrical of merit about them and which are, therefore, from an electrical standpoint at least, of a fraudulent nature. The promoters of wildcat schemes have but little knowledge of electrical matters, and all know that a little knowledge is a very dangerous thing—nevertheless, the general run of investors are not able to discern the facts and, being inevitably victimized, their minds are poisoned against the science of electricity as an investment and the whole industry suffers. Indeed, the time has come when the technical press to a unit should denounce all jobbery of the electrical industry as it would a pick-pocket.

The injury that has been inflicted upon the electrical industry by reason of fraudulent schemes in which miracle workings have been attributed to electricity, can never be estimated in money value for the reason that the injury is hidden in the form of suspicion and distrust of the legitimacy of many worthy electrical enterprises, as well as beause of a doubt that investment in an electrical enterprise is neither more nor less than embarking into an unknown sea in an untried, if not unworthy craft. Untold millions have been irrevocably sunk deep in the mire of the slough of electrical fakirism, and money is never lost without the shattering of some confidence or other. Capital has a discernment distinctively its own and its eyes, however keen in the world of finance, are little less than blind when in the atmosphere of electro technics.

One may, if clever in mental gymnastics, conjure up a harmless belief that electropoise cartridges, electric hair-brushes and electric insoles possess a consecrated ability to relieve pain, or to make bald heads hairy, or to warm feet that tend to chronic coldness, but the truth is that bread pills will prove equally efficacious if the patient has abiding faith in the physician who administers them. There is no suggestion of an electro-therapeutic property in even one-hundredth of the pseudo-electric cure-alls that are on the market, yet the subtle magic suggested in the word "electricity" charms away the common sense and dollars of the public, giving in return an imaginary alleviative that is electric only in name. But the public believes that electricity exerts some potent influence for good through the inert article that has been bought and reposes secure in an undefinable confidence that the "subtle fluid," though strange, is an exceedingly considerate genius—an administering angel truly. The fact is that the cures of electro-quackery are those of the well-masked influence of mind over matter, and electricity, like a flower of spring, has nothing to do with the case.

The lies of electro-quackery are white lies, for they generally go no further than to practice faith cure by disguised methods. They merely give the rose another name, even though, to electricians, that name suggests dank unsavoriness. But the lies of electro-fakirism are black lies, without a solitary redeeming trait, and their only purport is the ulterior one of inveigling capital into spurious electrical ventures, and, when all is lost, capital attributes its misfortune to electricity without discerning the spuriousness of the scheme or realizing the perfect innocence of the so-called "infant science." No one will gainsay the fact that fraudulent enterprises of a pseudo-electrical nature have fleeced capital out of many of its millions until capital, in turn, is prone to view with deep-rooted suspicion any electrical project, however meritorious.

It is this unfortunate condition of affairs that has caused many a legitimate electrical project to languish or be dropped altogether because of inability to interest capital in its development. On the other hand, capital appears to lend a willing ear to electro-jingoists, and it is a blessing that its unfortunate experiences are slowly teaching it that there is no magic about the word "electricity;" that its applications must meet all other industrial agencies on a neutral ground, where it must hold its own or be vanquished from the field of commercial supremacy.

Capital must study projects of an electrical nature from an electro-technical standpoint, as well as from the more familiar standpoint of financial or commercial feasibility, if it is to protect itself from the all-devouring sharks of electrical fakirdom.

STATION SWITCH-BOARDS.

Dr. Perrine's paper on Central Station Switchboards, presented to the San Francisco Convention of the Pacific Coast Electric Transmission Association, finds its great value in the emphasis it lays upon the necessity of surrounding the most vital, if not the most vulnerable, portion of the equipment of the power house with every possible safeguard, be it in the means for dissipating static charge, or in restricting arcing, liability of personal injury and the inflammability of the switchboard itself. Well is it stated that while there is nothing novel imparted by the paper, there is all the more reason that the suggestions contained therein should be enlarged upon and faithfully executed, for they are not always carried out in stations which are considered well designed. There is always room for the discussion of a theme of such general interest as that of switchboards and switchboard construction, and while one is in consonance with the treatment of the whole subject, he will be conscious that it sets forth one or two ideas with which his experience is not in entire accord.

Valuable indeed, however, are the speculations made in reference to the materials which may be used for switchboard building and to have concisely stated, as is there done, the advantages and disadvantages possessed by wood, slate, lava, marble, glass and porcelain for this class of work. Wood is inflammable, slate contains metallic oxides, lava is not available commercially, glass is expensive to work and porcelain can not be made in sufficiently large slabs. Thus is it then that marble is the most preferable because of its low cost, its ease of working, its non-inflammability, its non-metallic nature and its finished beauty of appearance. Some interest was awakened during the discussion of the paper by the suggestion that for low potential work, a good material for switchboards would be found in composite tiling cemented in a metallic frame, but the great difficulty of drilling tiling seemed responsible for its disapproval and the opinion which prevailed regarding its use was summarized in a pertinent observation by Mr. Beal who understood the tile question to be that one "must first get the hole and then put the tile around it."

There is yet, however, considerable room for improvement in methods of treatment and use of marble in building switchboards, and much remains to be investigated concerning the hygroscopic properties of marble, the action of direct currents on marble, the filling and polishing of marble, and concerning the influence which dust, settling on its generally unpolished back, exerts on the resistance of the marble board. These are among the important points brought out by a consideration of Dr. Perrine's paper. Prof. Cory states emphatically that marble is neither non-porous nor non-hygroscopic, and in support of this conviction, cites a series of experiments made by himself in which he found it necessary to get a resistance which would be of the nature of from thirty megohms to one thousand megohms for the purpose of testing the capacity of a condenser, and the materials tested for this resistance were slate, polished and not polished, japanned and not japanned, waxed and not waxed; marbles of various qualities; common porcelain, and high potential insulator porcelain. He found that an interesting thing about all of these was the difference in resistance at different temperatures, and that the resistance depended upon what had been the previous history of the material. He had a piece of Italian marble which was brought from a dark, cold basement where it had laid for three years untouched. It was tested and its resistance was found to be about thirty megohms; the marble was then placed on the cylinder head of a steam engine for a few minutes and again tested when its resistance was found to have increased to above one thousand megohms, the limit of the scale of the galvanometer. These experiments were repeated and the conclusions verified by the use of high voltage tests, and the conviction was reached that marble is both porous and hygroscopic.

The increased potentials used on long distance transmission lines and the necessity of constructing switchboards for controlling these extreme voltages will compel a more careful study of what may be termed the elusive properties of marble, than has heretofore been given. Moreover, it is very evident that there is necessity for polishing every portion of the switchboard instead of polishing the front alone, as the present universal practice. Neither dust nor the volatilized metal from fuse blowings or other arcings will impregnate polished marble, and in addition, filled and polished marble may be rendered practically impervious to the ordinary agencies that at present remove it to some slight degree from the proud position of being the perfect material for switchboard building. While the reduction of marble to lime by electrolysis may be theoretically possible, it certainly has not become manifest in practice and the use of alternating currents will minimize electrolysis to a negligible factor, if not to nullify its evil tendencies altogether.

The blackening of bus bars so as to faciltate the dissipation of heat and, in so doing, to increase their conductivity by reducing their temperature, is a point well taken, but the inference expressed that the water-proof character of the insulation used on switchboards may be sacrificed for the purpose of attaining non-inflammability, will doubtless be disputed on the tenable ground that waterproofing and fireproofing go hand in hand—that no non-waterproof circuit is proof against causing fire, or, to put the same statement in another light, that no non-fireproof circuit is absolutely fireproof if unable to resist the encroaches of moisture, that insidious but infallible forerunner of that oft-times incarnate fire-producer, electrolysis. Nor is it reasonable to contend that there is no likelihood of a switch-board ever being wetted, for a condition of permanent, absolute dryness can seldom, if ever, be assured. Fresno rested secure in the belief that it was beyond reach of a water damage until the bursting of an eighteen-inch underground main tore down its brick wall and, reaching an

arc switchboard and the step down transformers, flooded its sub-station. It is the unexpected that always happens and one must not forget that water in one form or another, is omni-present.

The question of inflammability of insulations has been threshed over so thoroughly that further discussion of it seems redundant. With the utmost brevity may it be stated, however, that strictly high grade insulation without the use of an inflammable covering, has not yet been attained. Such insulation is necessary to insure safety to life and property and the only disadvantage to be found in its use is that when ignited, it will carry fire. Then why not sheath it with a non-ignitable material, which will eliminate its only incendiary proclivity. Both fire-proofing and water-proofing, the two prime requisites for securing immunity from fire, will thus be aorded without either working to the disadvantage of the other.

FATALITIES FROM LOW-VOLT SHOCKS.

Four cases of death from electric shock occuring in a single chemical factory, the name of which is purposely withheld, are recorded in a German contemporary "Elektrotechnische Zeitschrift," of December 30th last, and the extraordinary feature is the statement that the fatal pressure could not have exceeded 230 volts alternating current! It appears that in the first instance the unfortunate man was standing barefooted on the ground turning a reel that raised an arc lamp, when a terminal of the lamp came in contact with a pulley that grounded the circuit through the workman. In the second instance the victim leaned out of a window and deliberately seized an overhead circuit outside; in the third case a live wire came in contact with an ungrounded metal pipe which contained it, the shock being given from the pipe; and in the fourth case the shock was attributed to a faulty flexible conductor or lamp fitting.

The article referred to is unsatisfactory in that in one portion it defines the circuit in question as being "a 230-volt three-phase system, mesh connected," while in another portion it states that "at all events in three out of the four cases the pressure to which the victim was subjected did not exceed 115 volts." Evidently then, the secondaries were in "Y" connection with 115 volts on a side, in which event the maximum circuit potential would be but a fraction under 199 volts ($115 \times \sqrt{3} = 198.9$ volts.) The exception referred to was probably the case in which the victim leaned out of the window, probably grasping two wires of a Y connected three-phase circuit, giving him a 200-volt shock. The other three cases seem to have been from 115 volts as stated. The four deaths occurred from the same wires within a period of sixteen months.

Startling as this experience is, there is no need for serious alarm as in all probability in extraneous causes will be found an acceptable solution of the apparent mystery. It is stated that the installation was placed in a thoroughly workmanlike manner, that tests had shown the insulation resistance to be high, but that considerable dampness existed. A leakage of high tension current from primary to secondary may have developed periodically by a "swinging cross" so that through coincidence, or rather through the absence of it, the grounding of the transformer may have escaped detection. Where deaths have occurred from low pressure shocks it has usually been considered that they were due to a weakened or affected physical condition, abetted by a good contact. The evil of good contact was evidently present in all of the fatalities cited and it is perhaps more than probable that the employees of the establishment were so emaciated if not diseased from the long-continued handling of chemicals that they were peculiarly susceptible to shock, with the result stated. It is not probable that a person who is salivated, for instance, would withstand a very severe electric shock.

Though these fatalities are deplorable, they cannot in any manner of reason, constitute an arraignment against the potentials that have been so universally adopted for both direct and alternating current distribution. Rather is it an arraignment of our civilization that has not found a means to avoid the sending of fellow beings to the living death of labor in certain forms of chemical factories.

Passing Comment

An Editorial Review of Current Events and Contemporary Publications.

THE "KILOVOLT-AMPERE."

The electrical engineering world is indebted to Steinmitz for the coining and introduction of a new and timely term that seems so natural and simple that the wonder is the need for it has not resulted in its creation long ago. The word referred to is "kilovolt-ampere," and the distinction between it and the familiar term "kilowatt" is at once apparent to all who have had to do with the exact measurement of alternating current. The kilovolt-ampere has come to stay and its arrival marks another of the few final steps that remain to be taken before the category of electrical nomenclature shall have been fully completed.

A CHANGE IN A CONTEMPORARY.

Congratulations are extended to the Electrical Review, the valued New York contemporary, on the reduction of the size of its pages to a more convenient dimension, as well as to its improved typographical appearance. The Review has a sphere of its own in which it is unapproached by any other electrical publication, and now that it is in handy form and otherwise improved, it is bound to be more prized than ever.

Pity 'tis that the electrical periodicals, like many of the publications of the engineering societies, can not be standardized in their dimensions.

Transportation

POLYPHASE MOTORS IN RAILWAY WORK.*

By Charles Proteus Steinmitz.

For controlling polyphase railway motors three methods are available:

First—Rheostatic control.

Second—Tandem-multiple control.

Third—Potential regulation, with short-circuited motor armature.

First—In rheostatic control the armature or secondary circuit of the motor is supplied with collector rings, across which the rheostat is connected. A rheostat in the main or primary circuit would reduce the torque per ampere proportionally to the reduction of voltage, due to the decrease of magnetization of the motor, and thus this method is not suitable for railway work. The advantages and disadvantages or rheostatic control are the same as on the direct-current system. The system is very simple, and the motors are satisfactory and efficient at full speed, but in starting and at low speeds power is wasted in the rheostat.

Second—Tandem-multiple control. Two induction motors in concatenation, that is, the secondary of the first motor feeding the primary of the second motor, reach their synchronous speed at half the synchronism of the alternating-supply current, that is at half the speed at which they would run in parallel connection. This method thus gives the same features as series-parallel control on continuous-current motors; that is, it approximately doubles the torque and saves the power wasted in the rheostat below half speed and reaches full efficiency at half-speed. Obviously, just as in series connection of continuous-current motors, the efficiency at half-speed is not quite the same as at full speed and parallel connection, since with the same torque the losses in the former case are double. Still, the efficiency with this method of connection is far superior to that attained by rheostatic control, and the starting current is less, but the controller is somewhat more complicated.

Third—The potential regulator offers the simplest arrangement. The motor has no collector rings, but a short-circuited high-resistance armature, giving maximum torque in starting, and the torque and thereby the speed is varied by varying the impressed voltage at the motor terminals. This is done by a potential regulator; that is, a transformer, or rather compensator, of variable ratio of transformation. Unfortunately with such a motor the efficiency at speed is lower than when rheostatic control is used and the apparent torque efficiency that is, the torque per ampere, is very low in starting. The motor requires in starting at least twice the current for a given torque that it would require with rheostatic control. Considering now that the starting torque of a railway motor must be at least from two to three times the running torque, the starting current with the potential regulator method is about four to six or more times the running current. Since, however, the torque of the motor falls off with the square of the voltage, still more current is required in starting, on account of the drop of voltage caused in the lines by the excessive starting current. In consequence of this if the drop in the lines is not very small, even at heavy overloads, the motor is liable to be stalled or to fail to start. In consequence thereof the potential regulator control, while apparently the simplest, is entirely unsuitable for most railway work, or any other work where heavy starting torque is required and the supply of power is not unlimited as compared with the size of the motor.

Comparing the relative advantages and disadvantages of polyphase and of continuous-current motors for railroading, we have as the foremost and dominant advantage of the continuous-current motor that it is standard apparatus, familiar to and well understood by everybody, and capable, with the help of rotary converter substations, of being used on roads at any distance from the power station. It requires a single trolley only, while the three-phase motor requires a double trolley.

On long-distance roads, however, the continuous-current motor requires rotary converter sub-stations, which need some attendance, while the polyphase motor only needs stationary transformers distributed along the line.

In starting, acceleration, efficiency, etc., both types of motors are about equal. In operation the polyphase motor is somewhat more reliable, due to the main current entering the stationary member only, and to the absence of the commutator. This advantage of the polyphase motor, however, is probably about offset by the greater familiarity of most people with the direct-current motor.

With the same voltage the three-phase railway system requires more copper in the lines, since the drop of voltage with the same current and size of conductor is greater in the polyphase system, being the impedance drop against the resistance drop with the direct-current system. A lesser drop of voltage in the lines must also be chosen in the polyphase system, since the torque of the motor decreases with the square of the voltage. Since, however, the three-phase current enters the stationary member of the motor only, and no commutator is used, a much higher voltage can be chosen in the trolley lines of the three-phase road than is permissible in a continuous-current road.

In the continuous-current motor the speed varies with the load, while the polyphase motor can maintain its speed irrespective of the load, and is thus better suited to keep its schedule time under all conditions of traffic. Hence, it is preferable for long-distance or interurban roads with single-track lines. In the polyphase motor

*An abstract from a contribution to the Electrical World, Vol. XXXI, No. 1.

all difficulties with the commutation are absent, and the structure of the motor is simpler, thus making it specially fit for heavy high-speed service, or for heavy service in general, as for hauling express or freight trains up grades, which are too steep for the steam locomotive to surmount them.

Fraternal

THE TRANSMISSION ASSOCIATION.

The San Francisco Convention of the Pacific Coast Electric Transmission Association was held in the offices of the Blue Lakes Water Co., in the Crocker Building, on February 15th, and the time of the open meeting of the Association was taken up in the reading and consideration of the paper of Dr. F. A. C. Perrine on "Central Station Switchboards," which is presented elsewhere in full.

During the executive session the following was adopted as the Constitution of the Association:

ARTICLE I.
NAME.

The name of this organization shall be "The Pacific Coast Electric Transmission Association."

ARTICLE II.
OBJECTS.

The objects shall be the collection and dissemination of information relative to the generation, transmission, distribution and utilization of electric energy, the discussion of all topics of kindred interest and the promotion of the best interests of its members.

ARTICLE III.
MEMBERSHIP.

The membership shall be divided into three classes, viz.:"Regular Members," "Associate Members," and "Honorary Members."

REGULAR MEMBERS.

Any corporation, firm or individual engaged in the generation and long distance transmission of electrical energy, and not engaged in the manufacture or sale of electrical apparatus or supplies, except the supplying thereof to customers of the transmission plant, shall be eligible to regular membership and shall become a regular member upon being nominated by a regular member and elected by a majority vote of all the regular members present at any regular or called meeting of the Association and the payment of membership fees and dues as hereinafter provided.

ASSOCIATE MEMBERS.

Any corporation, firm or individual engaged in the distribution of electrical energy, or engaged in the manufacture or sale of electrical apparatus or supplies, or any electrical, mechanical, hydraulic or civil engineer shall be eligible to associate membership, and shall become an associate member upon being nominated and elected and making payment of fees and dues as above provided with regard to regular membership.

HONORARY MEMBERS.

Any electrical, mechanical, hydraulic or civil engineer, or other person whose attainments or services to science shall merit the distinction, shall be eligible to honorary membership, and shall become an honorary member upon being nominated and elected as above provided with regard to regular members.

ARTICLE IV.
FEES AND DUES.

The fees and dues to be paid by the members of this Association shall be as follows:

REGULAR MEMBERS.

Regular members shall pay a membership fee of Ten (10) Dollars upon being elected, which shall be in full for their membership fee and of all dues until the next ensuing annual meeting. Annually after their election, or the first day of July each year, they shall pay the sum of Ten (10) Dollars as and for annual dues

ASSOCIATE MEMBERS

Associate members shall pay a membership fee of Ten (10) Dollars upon being elected and annual dues of Ten (10) Dollars on the first day of July of each succeeding year.

HONORARY MEMBERS.

Honorary members shall be exempt from the payment of all fees and dues.

ARTICLE V.
REPRESENTATION.

Each regular and each associate member shall be entitled to one representative at all regular and called meetings of the Association. Such representative to be a regular employee of such a member. Provided, however, that no regular member shall be entitled to send as representative any person who is engaged in the manufacture or sale of electrical apparatus or supplies. Also, provided, that associate and honorary members shall not be entitled to representation at the executive meetings of the Association. Honorary members shall be entitled to be present at all meetings of the Association other than executive meetings.

ARTICLE VI.
MEMBERSHIP PRIVILEGES.

The privileges attaching to membership in this Association are as follows:

REGULAR MEMBERS.

Regular members are entitled to participate in all meetings of the Association, to vote for the election of officers and new members of all classes, to serve upon committees, to participate in all discussions and generally to exercise all of the rights and privileges attaching to regular membership in similar associations.

ASSOCIATE AND HONORARY MEMBERS.

Associate and Honorary members are entitled to participate in all meetings of the Association other than executive meetings and to present papers for consideration and participate in all discussions other than those relating to the business of the Association. No associate or honorary member shall be elected to any official position in the Association; be appointed on any committee thereof charged with the conduct of any association business or entitled to cast a vote.

ARTICLE VII.
OFFICERS.

The officers of the Association shall consist of a President and a Vice President, who shall be representatives of regular members of the Association, and a Secretary and a Treasurer.

WHEN ELECTED.

The officers of the Association shall be elected at the regular annual meeting of the Association, or at an adjournment thereof.

TERM.

The term of office of any officer of this Association shall expire with the election and installation of his successor in office.

DUTIES.

The duties shall be such as usually attach to corresponding officers in similar associations.

ARTICLE VIII.

EXECUTIVE COMMITTEE.

The President ex officio and two regular members of the Association appointed by him and confirmed by the Association in executive session shall constitute an Executive Committee, which shall meet at the call of the President or any two of its members, and shall have power between meetings of the Association to dispatch all association business; to call special meetings of the Association, and at their discretion to take a letter ballot of the Association upon any question, and to canvass the same and render effective the results thereof.

ARTICLE IX.

MEETINGS.

The meetings of the Association shall be held from time to time as hereinafter specified.

ANNUAL.

The annual meeting shall convene in the city of San Francisco, California, on the third Tuesday in June of each year at such hour and place as may be designated by the Executive Committee.

SPECIAL.

Special meetings shall convene at such time and place as is designated at the adjournment of any proceeding annual or special meeting, or at such time and place as may be designated in the call thereof.

CALLS.

Calls for special meetings may be issued by the Executive Committee and shall be issued by the President on the written request of a majority of the full members.

NOTICE.

The Secretary shall give all regular, associate and honorary members twenty days' notice of the convening of any annual or special meeting by written or printed notice mailed to their several addresses as indicated by the records of his office.

ARTICLE X.

QUORUM.

A quorum for the transaction of business shall consist of the President, or, in his absence, the Vice President, and two regular members, or in the absence of both the President and Vice President, shall consist of five regular members.

ARTICLE XI.

VOTES.

Each regular member shall be entitled to one vote at all elections and upon all questions pending before the Association. Associate and honorary members shall not be entitled to vote.

ARTICLE XII.

PARLIAMENTARY.

Roberts' Rules of Order shall govern all questions of parliamentary usage and proceedure not governed by these by-laws or by some resolution or order of the Association.

ARTICLE XIII.

ORDER OF BUSINESS.

Unless dispensed with by a majority vote of the Association, the following shall be the order of business observed at all meetings:

1. Calling roll of regular members.
2. Enrolling of associate and honorary members in attendance.
3. Reading minutes of preceding meeting.
4. Reports of officers.
5. Reports of standing committees.
6. Reports of special committees.
7. Nomination and election of regular members.
8. Nomination and election of associate members.
9. Nomination and election of honorary members.
10. Reading of papers on set topics and discussion.
11. Reading of papers on special topics and discussion.
12. Proposal of set topics for next meeting and adoption.
13. Miscellaneous business.
14. Election of officers.
15. Adjournment.

ARTICLE XIV.

DEFNITION.

No corporation, firm or individual shall be construed to be "engaged in the generation and long distance transmission of electrical energy" within the meaning of section III of these By-laws unless the distance of transmission between the points of generation and principal point of utilization shall be five or more miles, nor unless the voltage between wires of main transmission line shall be 5000 or more volts.

ARTICLE XV.

AMENDMENTS.

These By-laws may be amended by a majority vote at any annual meeting without notice, or at any special meeting, provided the member desiring to propose an amendment hereto shall file a (notice and copy of such proposed amendment with the Secretary) thirty days in advance of such meeting. In event a copy and notice of a proposed amendment to these By-laws shall at any time be filed with the Secretary as aforesaid it shall be his duty to cause copies thereof to be prepared and mailed to each full member simultaneously with notice of the next meting.

Personal

Mr. C. S. Knight, of the Fort Wayne Electric Corporation will be in San Francisco about March 1st.

Mr. J. B. Crockett, President of the San Francisco Gas and Electric Company, is in Mexico on a pleasure trip.

Mr. John R. Cole, San Francisco representative of the New York Insulated Wire Company, is in New York City.

Mr. J. W. Godfrey, agent of sales for the India Rubber and Gutta Percha Insulating Company of New York, was in San Francisco last week.

Mr. Henry E. Vineing, mechanical and electrical engineer of New York, and late master electrician of the Brooklyn Navy Yard is in San Francisco, engaged in the supervision of the erection of the steam and electrical installation in the new "Examiner" building.

Mr. A. M. Hunt, principal member of the firm of Hasson & Hunt, consulting mechanical and electrical engineers of San Francisco, is, it is reported, about to withdraw from the co-partnership to accept the position of engineer-in-chief for the very extensive interests of the Alaska Commercial Company. Who will succeed Mr. Hunt as engineer for the firm named is not known, but it is certain that Mr. Hunt will be the recipient of the warmest congratulations from his fellow engineers who, without exception, respect the genious and admire the man now about to be so happily and deservedly promoted to a more congenial and lucrative association.

Dr. Louis Duncan, Past President of the American Institute of Electrical Engineers, has been appointed electrical engineer of the Third-Avenue Railway Company of New York, and will have charge of changing the road into an electric line. Three years of time and about $6,000,000 will be required to make the change. Dr. Duncan will not give up his work at the Johns Hopkins University, and will continue to make Baltimore his home. His assistant, Mr. Sydney H. Browne, will remove to New York about April 1 to devote his entire time and attention to the great undertaking of which Dr. Duncan will have general charge. Dr. Duncan is one of the most popular and able engineers in the profession, and the appointment will bring out a universal approval of the selection that has been made for this most important piece of overhead electric railway work that has been undertaken in America.

Industrial

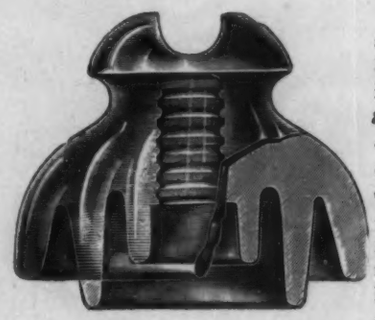
In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

EDISON LAMPS FOR ISOLATED PLANTS.

For isolated plants the General Electrc Co. have recently issued an incandescent lamp catalogue, which is something of a departure and which should be of special interest and value to all lamp users. This catalogue contains descriptions of the class of lamps used by Isolated Station plants. The omission of all other types of lamps has made the catalogue a simple, concise pamphlet. It is something more than a catalogue, in that it contains several opening chapters of special value to lamp users, discussing improved methods of manufacture and showing how important special experience and facilities are in the production of the highest quality of incandescent lamps. Following this, the subject of selection of lamps is discussed with the idea of assisting the customer to obtain the lamp best suited to his conditions. Then an account is given of the requirements for the proper use of lamps and a pertinent example figured out showing the saving to be effected by proper lamp renewals.

Following this are descriptions of the standard lamps as used by isolated plants, each description being accompanied by full sized illustrations of the lamps. Among others, the catalogue contains an account of 250 volt lamps. The catalogue is excellently gotten up, typographically, and contains a folder giving prices of the various types of lamps. The General Electric Co., have endeavored to send copies of this catalogue to every isolated plant in this country and will be glad to furnish copies to any plant or customer desiring the same. Such a useful treatise should be in the hands of every purchaser of incandescent lamps, and retained by them as a book of reference.

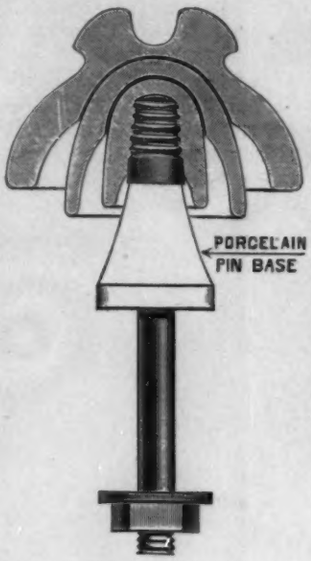
"LOCKE" HIGH POTENTIAL INSULATORS.



Much has been written and a great deal more has been said about the superiority of porcelain over glass in the manufacture of insulators for high potential circuits, on account of the knowledge that under ordinary conditions, glass was hygroscopic and more friable than porcelain. This was quite true of glass insulators, as ordinarily manufactured, and with a knowledge and clear understanding of these deficiencies Mr. Fred M. Locke of Victor, N. Y., undertook their remedy, and as a result produced the insulator illustrated in this column. This insulator is very similar in general form to the familiar "Locke" No. 3, porcelain insulator, so largely used in California, but it is however considerably larger, being 5½ inches in diameter. The great point of difference between this insulator and other glass insulators lies in the fact that the Locke insulator is made of a tough glass, which after manufacture is carefully annealed, the product being an insulator which is as tough as porcelain and which it is practically impossible to puncture. While a laboratory test may develop considerable difference in the hygroscopic properties of the two materials, it is not borne out in practice, since the deposit of dust and dirt on the outer petticoats of insulators on a line practically eliminates this consideration. These insulators are now all sold subject to a guarantee to withstand a test of 50,000 volts.

These conditions, together with that of the actual cost, have resulted in the adoption of this insulator for all high voltage power transmission lines in California that have been built since it has been placed upon the market, and for electro-motive-forces as high as 20,000 volts. These insulators are to be used on the transmission line now being built over the Chilcoot Pass in Alaska, and also on the Goldstream-Victoria transmission line of the British Columbia Electric Railway Company; in this latter case the entire contract for line material having been placed with Mr. Locke.

There are still those who prefer porcelain insulators. In very moist climates they are no doubt preferable, and for this class of work the "Locke" three part china insulator has been developed.



This insulator is made up of three glazed shells of vitrified china, glazed inside and out and then fused together to form a single insulator, as shown in the accompanying cut, being thoroughly vitrified before glazing. Should the glass be injured by impact or otherwise, by reason of its vitrification the insulator will not absorb moisture. These insulators recently withstood a dry test of 72,000 volts and a wet test of 54,000 volts, at which voltages the arcs followed around the petticoats. The test showing conclusively that porcelain insulators manufactured in this way are capable of withstanding the high voltages now in use or in contemplation.

The cut of this insulator here shown also illustrates the "Locke" steel pin with a porcelain base. The heavy copper wires used in transmitting large blocks of power have necessitated radical improvements in line construction and the old and familiar oak pin, one and a half inches in diameter has had to be discarded in many cases. Boring the cross arms for these large pins materially weakens them, and even where it is possible to increase the cross section of the arm, the wood pin itself is a source of weakness, not only on account of the strains introduced by the weight of the wire supported, but also on account of its liability to be burnt off by the static discharges between the insulators and pins. These difficulties have been met by the "Locke" pin, which is a steel pin with a wood top and a vitrified and glazed porcelain base, which extends from under the petticoat of the insulator to the cross arm. The steel pin is 7-16 in diameter, and only a ¼-inch hole in the cross arm is necessary, and since the porcelain base receives all static discharges, no burning of the cross arm or pin is possible. This is not merely a theoretical condition, but is an actual one that has been demonstrated by experience in many cases.

These pins are to be used by the Southern California Power Company for their 33,000 volt transmission into Los Angeles; the San Joaquin Electric Company's 20,000 volt transmission to Hanford, Cal., and by the Yuba Power Company on their 16,500 volt transmission to Marysville, Cal.

Mr. Locke is represented on the Pacific Coast by Mr. Jno. Martin, 300 California Street, San Francisco, where samples may be seen.

AN INVALUABLE BOOK FOR LAMP USERS.

A catalogue recently issued by the General Electric Company forms the most complete publication of the kind ever produced,

being nothing more or less than an exhaustive treatise on Incandescent Lamps from the customer's point of view. The catalogue begins with introductory chapters on the "Production, Selection and Use of Lamps," in which are set forth in a concise, telling manner the methods which have given the Edison lamp its marked superiority, as well as an account of the importance and value of skill and experience in lamp production, and how to select the type of lamp best suited to the purchaser's conditions, together with the necessary requirements for the proper use of lamps. Descriptions of the various types of lamps follow the introduction and a full sized illustration accompanies each lamp described. The descriptions and illustrations include every class of lamp manufactured by the General Electric Company, of which there are over 30,000 varieties, including the various voltages and candle powers, etc., and of which there are produced and sold annually over 6,500,000 lamps.

Following the description of the lamps is an "Appendix of Information on Incandescent Lamps" of great value to all lamp users. The opening discussion is on the "Life and Candle Power of Lamps, in which the subject of decline of candle power and its bearing upon the lamp renewals is clearly set forth. Following this is a chapter on the "Importance of Good Regulation," and additional chapters on the "Method of Measuring Lamp Value by Candle Power and Area," "Special Points to be remembered in the use of Lamps," "Faults in Incandescent Lamps," and tables of lamp data. The concluding chapters of the appendix are given to the subject of "General Illumination," the "Correct Use of Light" and "How to Avoid Harmful Effects on the Eyes."

Altogether the catalogue is the most complete and interesting commercial treatise on incandescent lamps ever produced. Its typography is excellent and the illustrations of the lamps are well designed and executed, making it altogether a valuable and useful book of information and reference. Copies have been sent to all station managers in the United States and can be obtained from the General Electric Company's Lamp Works, Harrison, N. J., or at the nearest local office.

In this connection, the General Electric Company desires to advise all holders of this Catalogue (No. 1012) of an error in the appendix, in the table on page 58. The figures .662 in the column "Life Factors" should be .562. The company kindly requests that all holders of the catalogue make this correction.

SPECIALTIES IN INCANDESCENT LAMP SHADES.

The Pacific Electric Company, of La Crosse, Wis., has made such a thorough study of the science of perfecting appliances for delivering incandescent light just where it is wanted, that it has become a specialist of national reputation in that particular direction. It has perfected a great many unique designs of what might be called "lighting novelties," one of which is illustrated herewith.

As is evident, this novelty consists of a "Bed Lamp," that is an incandescent lamp by which to read while in bed, and its eminent utility will be appreciated by all who are given to enjoying the satisfaction of reading "just a page or two" before going to sleep. Invalids, too, can find comfort in reading with this Bed Lamp when it would be impossible to do so otherwise, for the reason that the light is delivered directly on the page, so that reading is made easy without imposing strain of any nature on the eyes.

In all, there are ten or more different styles of these shades, suitable for use as parlor, piano, typewriter, standard or student lamps, or, if desired, the shade may be fitted for attachment into electric light sockets. Great attention has also been given to the perfection of the details of special swinging arm styles of shade lamps, suitable for physicians', surgeons' or dentists' uses, as well as for the use of the library or study.

Descriptive pamphlets of these useful devices will be furnished on application to the Pacific Electric Company, 120 Main street, La Crosse, Wis.

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